

The Human Alogarithm: How Behavioral Economics and Green FinTech Can Enchanche Water Sustainability and Social Well-Being

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ABSTRACT

Water scarcity and unsustainable management present critical challenges to environmental and social well-being. The global water crisis demands solutions that are not only multidisciplinary but also comprehensive in addressing technical, behavioral, and institutional dimensions. Previous studies have remained fragmented, examining either behavioral economics or technological innovations in isolation. While traditional economic approaches have struggled to effectively address these challenges, the integration of behavioral economics with Green Financial Technology (Green FinTech) offers innovative and holistic solutions for water sustainability. This study provides a comprehensive examination of how behavioral insights and digital financial tools can incentivize sustainable water use while enhancing community welfare. The primary objective is to analyses synergies between behavioral economics (e.g., nudges, social norms) and Green FinTech (e.g., blockchain-based water trading, gamified conservation savings) in promoting equitable water sustainability outcomes. Using a systematic literature review (SLR), this research synthesizes peer reviewed articles, reports, and case studies (2014-2024) from Scopus, Web of Science, and Google Scholar. The PRISMA framework guided the selection and thematic analysis of 81 studies. Key findings reveal: (1) Behavioral interventions (e.g., real-time usage feedback) reduce water consumption by 12-25% in experimental settings; (2) Green FinTech platforms enhance transparency in water credit systems and empower marginalized communities; and (3) Combined approaches strengthen policy compliance and collective action. However, scalability depends on contextual factors including digital literacy and institutional trust. The conclusion highlights the transformative potential of human-algorithm collaboration ("The Human Algorithm") in sustainability governance. Policymakers and FinTech developers should codesign context sensitive tools that align economic incentives with ecological and social objectives.

Keywords: Behavioral Economics, Green FinTech, Water Sustainability, Social Well-being, Systematic Literature Review

1. INTRODUCTION

The global water crisis is a multidimensional challenge that threatens environmental resilience, social stability, and people's economic well-being (Dogo et al., 2019). Various regions of the world, including developing countries and densely populated urban areas, face serious gaps in access to clean water, increased pressure on water resources, and weak governance and consumption efficiency (Yasmita, 2023). These problems not only have an impact on environmental sustainability, but also contribute to poverty, inequality, and social conflict.

This situation is a global concern that is explicitly stated in the Sustainable Development Goals (SDGs) agenda, especially Goal 6 (Clean Water and Sanitation) which emphasizes universal access to clean water and safe and sustainable sanitation systems (Mabalay, 2025). In addition, the linkage of water to Goal 3 (Good Health and Well-Being) (Wicaksana, 2023a),

Goal 11 (Sustainable Cities and Communities), and Goal 13 (Climate Action) show that unsustainable water management will hinder the achievement of overall sustainable development (United Nations Development Programme, 2024). Despite many technical efforts and conventional policies, the pace of change in public and institutional behavior towards water conservation is still far from adequate.

Based on these problems, there is a need for a behavioral economics approach as a new framework that is more contextual and humane, but has not been fully prioritized in water management policies and systems. On the other hand, the development of Green Financial Technology (Green FinTech) offers great potential to support the goals of the SDGs by combining digital innovation and sustainability principles. Green FinTech can also increase accountability and expand access to finance and information, especially for vulnerable groups.

Previous research with the systematic literature review has discussed separate concepts such as research that only focuses on IoT language on water conservation (Zulkifli et al., 2022) and research that focuses on the challenges and motivations of green fintech (Rahmantari et al., 2025). In fact, the integration between human algorithms (human logic and emotions in decision-making) and digital algorithms (green technology and financial systems) has a great chance of becoming a transformative strategy in achieving water sustainability and social welfare.

Based on this urgency, this study aims to investigate the integration between behavioral economics and Green FinTech as a comprehensive approach in strengthening sustainable and inclusive water management policies and practices, with a direct orientation on achieving SDGs targets. The study is expected to make relevant scientific and policy contributions to accelerate the transition to a just, adaptive and value-based water system that is global sustainability values.

2. METHODS

The study uses the Systematic Literature Review approach with the PRISMA model which refers to the writing of Kitchenham, B (Kitchenham, 2004) There are 3 stages of mapping carried out: First, the collection of 155 articles with keywords from Google Scholar, Growing of Science, Science Direct, and Taylor and Franchices and Emerald. The key words are in the form of “behavioral economics and water conservation”, “green fintech and environmental sustainability”, “fintech for water management”, digital behavior “change for sustainable water use”, “technology and social well-being in water sustainability”, “behavioral insights in environmental policy”, “green fintech applications for public utilities”.

The second stage in this process is to make an initial identification of the article by considering the title, abstract, and keywords relevant to the topic of literature review. Articles that are untopic-related, inaccessible, or illegible will be removed from the selection process. Only articles that show the suitability of the content with the focus of the study and keywords will be continued to the next stage. The selected articles will then be evaluated for important elements such as background, objectives, methods, results, discussion, and conclusions.

The last stage of this process is to conduct a synthesis analysis of the findings of the selected studies. At this stage, identification and analysis of the main concepts and themes that appear consistently in these studies are carried out. Furthermore, these results are summarized based on previous research findings to uncover research gaps that are still not widely discussed. The process of presenting findings is carried out in an integrated manner through a synthesis approach to provide a comprehensive overview of the development of related studies.

3. RESULT AND DISCUSSION

3.1. Result

The article selection process from 2014-2024 resulted in 155 articles after removing duplicates. Filtering by title, abstract, and keywords leaves 90 articles. Articles that are inaccessible or irrelevant are then deleted as many as 9, leaving 81 articles to review. In addition, the trend of publication regarding this research is increasing, in 2014 there are 2 articles, in 2015 there are 1 articles, in 2016 there are 1 articles, in 2017 there are 5 articles, in 2018 there are 3 articles, in 2019 there are 9 articles, in 2020 there are 6 articles, in 2021 there are 3 articles, in 2022 there are 14 articles, in 2023 there are 10 articles and finally in 2024 there are 27 articles. Based on the collected articles, research on water sustainability synergies in various countries including Indonesia, the United States, Europe, India, China, Japan, South Africa, Australia and Korea

The article is analyzed, divided into themes and subthemes based on the research focus which is the synergy between behavioral economics and Green FinTech in promoting equitable water sustainability outcomes for the social welfare of communities presented in a table that includes previous researchers, themes, and subthemes found. This research focuses on systematic literature review which refers to various research methods from selected articles in obtaining research results.

Table 1. A table of grouping themes and subthemes by included articles

Theme	Sub Them	Researchers
Behavioral Economics	Nudging in Water Efficiency, Social Norms and Water Conservation, Framming Effect in Water Education, Time Discounting, Social Comparison Feedback, Commitment Devices, Mental Accounting, Herd Behavior, Present Bias.	(Abas et al., 2022; Agramont Akiyama et al., 2022; Arsana et al., 2022; Brent et al., 2015; Brick et al., 2023; Carrión-Mero et al., 2021; Clot & Stanton, 2014; Dennis & Brondizio, 2020; Doran et al., 2017; Fielding et al., 2019; Goodwin et al., 2018; Greenaway & and Fielding, 2020; Haeffner et al., 2023;

Theme	Sub Them	Researchers
Green Financial Technology		He et al., 2024; Holland et al., 2019; Hu et al., 2024; Jorgensen et al., 2014; Kandul & Lanz, 2018; Li et al., 2022; Lurbé et al., 2023; Martínez & Maia, 2021; Mu et al., 2024; Otaki et al., 2017; Ramli, 2021; Rosdiana, 2019; Schultz et al., 2019; Shetu et al., 2022; Sohu et al., 2024; Tiefenbeck et al., 2019; Tomic et al., 2024; Wang et al., 2022; Werthschulte & Löschel, 2021; White et al., 2024; Zenelabden & Dikgang, 2022; W. Zhang et al., 2016)
	Blockchain-Based Water Trading, Gamified Conservation Savings, Token or Water Credits, Water Crowdfunding Digital, IoT-based Water Consumption Tracking, ESG rating tools	(AboAlsamh et al., 2023; Addy, 2024; Albertarelli et al., 2018; Allahham, 2024; Aysan & Syarif, 2024; Beisland et al., 2022; Bhattacharya et al., 2022; BORDEL et al., 2019; Brears, 2023; Castelletti et al., 2019; Chowpradith, 2020; De Barros et al., 2017; Dogo et al., 2019; Doni & Johannsdottir, 2019; Elias, 2024; Fuentes & Mauricio, 2020; Furones & Juan, 2023; Guillén et al., 2022; Hénisz & McGlinch, 2019; Hogeboom et al., 2018; Irianto, 2022; Kaur & Oza, 2020; Koroleva & Novak,

Theme	Sub Them	Researchers
		2020; Lin et al., 2017; A. Liu et al., 2017; Y. Liu & Shang, 2022; Mudalige, 2023; Nalumenya et al., 2024; Pee, 2018; Quesnel et al., 2017; Satilmisoglu et al., 2024; Simamora et al., 2024; Soeta et al., 2023; Tahir & Danarsari, 2023; Tamasiga et al., 2022; Tiwari et al., 2020; Torres-Toukoudidis et al., 2022; Uddin et al., 2019; Ugochukwu, 2024; Walter, 2024; Wicaksana, 2023b; Wong et al., 2018; Y. Zhang et al., 2020; Y. Zhang, 2023; Zheng & Siddik, 2022; Zulkifli et al., 2022)

3.2. Discussion

3.2.1. Economic Behavior Interventions in Water Consumption Management for Sustainability Efficiency

Efficient and sustainable management of clean water use has always been a challenge in itself along with increasing water needs, climate change, and environmental degradation (Haeffner et al., 2023; Ramli, 2021). Changes in water use behavior at the individual level are still difficult to do despite the implementation of progressive tariffs and infrastructure improvements (Torres-Toukoudidis et al., 2022). In this case, economic based interventions show effective behavioral changes within budget.

By conducting counseling or educational campaigns through community psychology, the reduction of water consumption can be drastically reduced ranging from twenty to twenty-five percent (He et al., 2024). When compared to the results of campaigns without psychological strategies, the figure is much higher (Carrión-Mero et al., 2021; Li et al., 2022; Zimmermann, 2024). This decline can be explained by a theoretical approach touching on cognitive, emotional, and socialized decision-making aspects in society.

One of the commonly used methods is nudging, which is encouraging a person to change their choices without coercion (Brichet et al., 2023; Cole et al., 2021). For example, with the use of automatic water taps, digital reminders, and household devices that have presets to drain water in minimal amounts. These can all form a water-saving habit without causing resistance. Through this, even small changes in the context of decisions can have a big impact (Brick et al., 2023).

In addition to rules and technology, people's daily behavior also plays a big role in saving water (Brick et al., 2023; Haeffner et al., 2023; He et al., 2024). One approach that has proven effective is to take advantage of social norms, namely the tendency of individuals to adapt to the habits of others around them (Brent et al., 2015). For example, when a person finds out that his neighbor uses water more economically, there will be an urge to do the same so as not to look wasteful. This effectiveness is further increased with social comparison feedback, in the form of information that shows the comparison of water use between houses (Brent et al., 2015; Brick et al., 2023; Doran et al., 2017). This approach is able to significantly and sustainably reduce water consumption, as many people tend to follow the majority in order to be socially accepted, this phenomenon is known as herd behavior (Brick et al., 2023).

In public education, the way of delivering information (framing effect) is also very influential. Information conveyed with a particular point of view can shape different perceptions (Greenaway & Fielding, 2020; Holland et al., 2019). For example, the statement "if you don't save water, a crisis can happen" will feel more urgent than "saving water is good for the environment". With the right framing, conservation messages become stronger and drive action (Agramont Akiyama et al., 2022; Goodwin et al., 2018).

Another challenge in water conservation is the existence of time biases, such as time discounting and present bias, where individuals prioritize current comfort or benefits over long-term impacts (Hu et al., 2024; Werthschulte & Löschel, 2021). This causes water savings to tend to be ignored because the benefits are not felt in the near future (Werthschulte & Löschel, 2021). Therefore, intervention strategies need to be designed so that the benefits of conservation are felt more directly, for example through tangible incentives or reminders that today's unwitting waste of water will have a direct impact on tomorrow's water bills or availability (Haeffner et al., 2023; Pierce et al., 2021).

A strategy that can be said to be quite effective is to use voluntary commitment devices where a person or group of people promise to reduce water consumption, either through writing, digital and even public declarations (Kurniadi et al., 2025; Yasmita, 2023). In this case, such a commitment has been shown to be effective in increasing responsibility as well as consistency in its behavior. Of course, if done together, the impact can be much greater

There is also the concept of mental accounting, which is the habit of a person grouping the use of water for bathing, washing, or watering plants and considers a part of the user to be "indelible" (W. Zhang et al., 2016). By studying this pattern, especially for water resource managers, it will create a more targeted tariff system and educational programs in encouraging savings in all aspects of use (Coulson et al., 2021; W. Zhang et al., 2016). The combination of the approaches mentioned above results in strategies that are more personalized, contextual and

relevant. One of the powerful policy tools to face the challenges of water management is not forced, but understood in the day-to-day decision-making process.

3.2.2 Green FinTech for Transparency in Water Sustainability Systems

Green FinTech combines the use of digital technology, green finance principles, and a participatory approach to support water management with data, rigorous systems, and open to the public and inclusive (AboAlsamh et al., 2023; Zheng & Siddik, 2022). One of the exciting Green FinTech innovations is the application of blockchain in water trading (BORDEL et al., 2019; Y. Liu & Shang, 2022). With this technology, water usage rights can be recorded securely and transparently and allow users such as farmers, industries, or households to transact directly without intermediaries (Lin et al., 2017).

Through smart contracts, the distribution of water allocation can be automatically controlled based on quotas, certain seasons, or certain environmental conditions (Satilmisoglu et al., 2024; Tiwari et al., 2020). This makes water distribution not only more efficient but also fairer. In addition, the entire digitized process prevents data manipulation and conflicts due to the anti-interference ecosystem (Y. Zhang et al., 2020).

In addition, tokenization-based and digital-based incentive approaches provide new ways to encourage water conservation (Fuentes & Mauricio, 2020; Irianto, 2022). In the water credits system token, users who manage to save water use are entitled to receive digital tokens as rewards (Elias, 2024; Kaur & Oza, 2020). In the water credits system token, users who manage to save water use are entitled to receive digital tokens as rewards (Kaur & Oza, 2020).

On the other hand, gamification elements in water management platforms are starting to be used in a more fun way to encourage behavioral changes towards more economical consumption (Bhattacharya et al., 2022; Guillén et al., 2022). Apps with points, challenges, digital badges, and ranking systems have been shown to increase public participation in water-saving programs (Koroleva & Novak, 2020; Mabalay, 2025). Gamification makes conservation activities less burdensome while fostering environmental awareness through friendly competition and social interaction (Albertarelli et al., 2018).

In terms of financing, digital crowdfunding platforms are innovative solutions for individuals or communities who want to collectively fund specific water-related projects such as building clean water supply networks, efficient irrigation systems, or spring conservation (Mukherjee et al., 2024). Open and participatory funding allows local initiatives that previously struggled to access formal funding to realize projects through transparent public contributions while ensuring accountability and good management (Haefner et al., 2023; Quesnel et al., 2017). One of Green FinTech's key strengths lies in its ability to integrate real-time data with incentive systems.

Utilizing Internet of Things (IoT) technology, water consumption can be monitored in real-time using sensors and smart meters (Irianto, 2022; Uddin et al., 2019). The resulting information not only provides detailed insights into water usage but also enables early warning systems for leaks, waste, or inefficient consumption patterns (Fuentes & Mauricio, 2020; Solgi et al., 2020).

Users are presented with this data through an accessible digital dashboard and can view it in correlation with dynamic pricing or incentive-based penalties (Furones & Juan, 2023; Y. Zhang et al., 2020). Every innovation moves in one interconnected ecosystem, blockchain becomes a step of transaction transparency, digital tokens provide real-time incentives, gamification encourages emotional engagement, crowdfunding enables community-centric financing, IoT supplies the right flow of data, and a company's ESG (Environmental Social Governance) rating strengthens corporate accountability (Doni & Johannsdottir, 2019; Irianto, 2022; Y. Zhang et al., 2020; Zulkifli et al., 2022). This means that it is not just about the technology in Green FinTech but about fundamentally restructuring the water system to make it more equitable, transparent, and sustainable by integrating humanity, data, and green finance in a cohesive synergistic framework (Kaur & Oza, 2020; Wong et al., 2018).

With this approach, water resource management becomes more than just a technocratic task; It is developing into part of a technology based multilateral collaborative movement that brings together environmental, social, and economic interests. Green FinTech has the potential to unlock a transformative governance framework for water resources in the digital age while addressing future challenges through an inclusive, scalable, and value-oriented approach.

3.2.3 Integration of Economic Behavior Approaches and Green Technology in Water Policy for Community Social Welfare

Sustainable water management policies cannot rely solely on technical and infrastructure aspects. Long-term changes that have an impact on efficiency, equity, access, and social welfare of the community are highly dependent on two key complementary approaches, namely the economic behavior approach and the use of green financial technology.

From the point of view of economic behavior, it describes valuable information regarding decisions related to water consumption (Brick et al., 2023). Small interventions in the delivery of information and choices related to 'nudging' as well as social comparisons, binding tools, and frame effects suggest that they can bring about major changes in water saving behavior and social responsibility (Agramont Akiyama et al., 2022; Brick et al., 2023; Wang et al., 2022). Motivation for adjustment along with conservation tends to increase when individuals are given a visual comparison of their group's social average. The urgency of action is also driven when conservation risks are packaged in such a way (framing) in the message (White et al., 2024).

Meanwhile, green technologies, especially those developed through Green FinTech, provide concrete instruments to strengthen the effectiveness of such behavioural approaches. Technologies such as IoT-based smart meters, tokenization and gamification platforms, and digital crowdfunding for community water projects enable communities not only as objects, but also as active subjects in water governance (Tamasiga et al., 2022; Wong et al., 2018; Zulkifli et al., 2022). Real-time data collected from water use can be directly linked to digital incentives or visual feedback, which reinforce behavioral effects and foster sustainable awareness (Castelletti et al., 2019; Fuentes & Mauricio, 2020).

The integration of these two approaches in water policy creates a holistic ecosystem that combines psychological power, economic incentives, and digital technologies to drive water

system transformation. For example, a policy that combines positive framing education, a digital token incentive system for water-efficient users, and IoT-based consumption monitoring, will have a greater impact on changing behavior than conventional tariff policies or regulations alone (Holland et al., 2019; Irianto, 2022; Pee, 2018).

The impact is not only on water saving, but also on improving the social welfare of the community (Li et al., 2022). When water systems are managed in a transparent, equitable, and participatory, equitable way to clean water becomes more equitable. Residents in remote areas can participate in water projects through digital crowdfunding with local communities can build conservation systems with blockchain-based tokenization and tracking support; and vulnerable households can be involved in gamification-based water-saving programs that are fun and not burdensome (Quesnel et al., 2017).

Furthermore, policies that integrate this approach support the principle of water equity, which is to ensure that every community group, including the poor and vulnerable, has equal access to water resources (Yasmita, 2023). In addition, data-based systems and digital transparency also strengthen the accountability of governments and service providers, which directly or indirectly contribute to increasing public trust and social stability (Walter, 2024).

Thus, the integration between economic behavior approaches and green technologies in water policy is not only relevant for technical efficiency, but also strategic in order to realize the social welfare of communities through more inclusive, equitable, and sustainable water governance. This approach creates policies that not only regulate, but also inspire and empower communities in preserving water as a source of shared life.

4. CONCLUSION

Sustainable water management does not rely on technical or regulatory approaches alone, but requires integration between economic behavior interventions and green fintech-based green technology innovations. Behavioral interventions such as nudging, social norms, framing and commitment devices have been proven to be able to significantly and sustainably change water consumption behavior. On the other hand, Green Fintech technologies such as blockchain, IoT, Tokenization, gamification, and digital crowdfunding provide concrete instruments for transparency, incentives and active participation of the community in water governance. The integration of these two approaches in water policy not only promotes technical efficiency and water conservation, but also strengthens water equity, increases public accountability, expands access to clean water, especially for vulnerable groups, and creates a water governance system that supports environmental sustainability and social welfare of the community in a sustainable and transformative manner.

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